

DRAFT

APPENDIX A

FUNCTIONAL AREA TEMPLATES

This section presents and describes functional area templates (FATs) that were derived from a decomposition of the Brawler simulation into a hierarchy of functions suitable for targeting V&V efforts. The templates are organized in a top-down fashion, as is illustrated in Figure A-1.

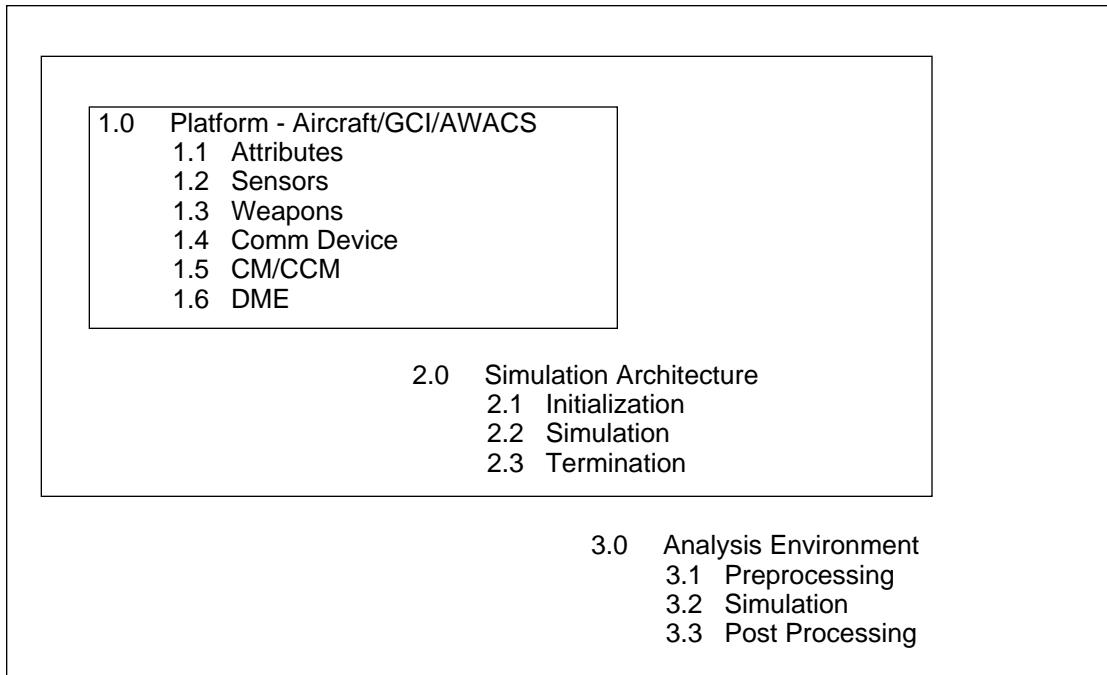


FIGURE A-1. Functional Area Template Organization.

Section I, Analysis Environment, outlines the various tools that comprise the entire Brawler package. These tools include utility programs for the development and verification of input data as well as post-processors for analysis and report generation. This section is intended to answer questions about the steps involved in performing studies with Brawler and the nature of the tools available to help with each of those steps.

Section II, Simulation Architecture, outlines the structure of the main simulation program *tbmain*. It is intended to answer questions about how the main simulation functions and to assess the suitability of interfaces between Brawler and other simulation applications.

Sections III and IV, Operator Models and Physical Models, and the sections that follow them, provide details on the modeling of real-world systems and subsystems in Brawler. The Operator Models section deals with the simulation of decision makers, and the Physical Models section deals with the simulation of platforms, weapons, avionics, and countermeasures.

DRAFT

PLATFORM AIRCRAFT

- 1.0 Attributes
 - 1.1 Configuration
 - 1.1.1 Pylons
 - 1.1.2 External Tanks
 - 1.1.3 Bombs/Pods
 - 1.2 Movement
 - 1.2.1 Propulsion
 - 1.2.2 Aero/Kinematics
 - Control Rates
 - Final States
 - 1.3 Signatures
 - 1.3.1 EO
 - 1.3.2 IR
 - 1.3.3 RF
 - Static
 - Dynamic*
 - 1.4 Vulnerability
- 2.0 Sensors
 - 2.1 *Acoustic*
 - 2.2 EO
 - 2.3IRST
 - 2.4 RF
 - 2.3.2 TTR
 - 2.3.3 RWR
 - 2.3.4 IFF/NCID
 - 2.3.5 MW/MAW
- 3.0 Weapons
 - 3.1 Guided
 - 3.1.1 Air-to-Air
 - 3.2 Ballistic
 - 3.2.1 Guns
- 4.0 Comm Devices
- 5.0 CM/CCM
- 6.0 DME - Pilot/GCI/AWACS
 - 6.1 Situation Update
 - 6.2 Situation Assessment
 - 6.3 Decision Logic
 - 6.4 Degraded Capabilities

II SIMULATION ARCHITECTURE

- 1. Initialization
- 2. Simulation
 - 2.1 Time Synchronization
 - 2.2 Event Handling
 - 2.2.1 Event Scheduling
 - 2.2.2 Event Execution
 - 2.2.2.1 Operator Models
 - 2.2.2.2 Physical Systems Models
 - 2.2.2.3 Simulation Management
 - 2.2.2.3.1 History Updates
 - 2.2.2.3.2 External Message I/O
 - 2.2.2.4 Statistics Collection
 - 3. Termination
 - 3.1 Statistics Compression
 - 3.2 Close Connections
 - 3.3 Close Files

III ANALYSIS ENVIRONMENT

- 1. Preprocessing
 - 1.1 Data Plotting
 - 1.2 Data Description
 - 1.3 Missile Envelope Plots
 - 1.4 Missile Kinematic Envelope Generation
 - 1.5 E-pole Generation
 - 1.6 F-pole Generation
- 2. Simulation Architecture
- 3. Post Processing
 - 3.1 Graphics
 - 3.2 Statistics Reports

DRAFT

III OPERATOR MODELS

- 1. Pilot Model
- 2. GCI/AWACS Controller
- 3. SAM Operator

IV PHYSICAL SYSTEMS

- 1. Aircraft
- 2. Weapons
- 3. Sensors
- 4. Countermeasures
- 5. Fire Control Device
- 6. Jammer Pods
- 7. External Fuel Tanks
- 8. Pylons

DRAFT

DME PILOT/OPERATOR MODELS

- 6.0 DME - Pilot/GCI/AWACS
 - 6.1 Situation Update
 - 6.1.1 Make Observations
 - 6.1.1.1 Performance
 - 6.1.1.2 Physical State
 - 6.1.2 Process Observations
 - 6.2 Situation Assessment
 - 6.2.1 Process Intent-to-Fire Msgs.
 - 6.2.2 Process Orders
 - 6.2.3 Prioritize Other Measures
 - 6.2.4 Detect Problems
 - 6.2.5 Damage Assessment
 - 6.2.6 Missile Assessment
 - 6.3 Decision Logic
 - 6.3.1 Project Situation
 - 6.3.2 Production Rules
 - 6.3.3 Set Decision Level
 - 6.3.4 Make Decision
 - 6.3.4.1 *pkactn* Formalism
 - 6.3.4.2 Flight Posture
 - 6.3.4.3 Flight Tactics
 - 6.3.4.4 Radar Mode
 - 6.3.4.5 Maneuver
 - 6.3.4.6 Weapon
 - 6.3.5 Implement Decision
 - 6.4 Degraded Capabilities
 - 6.4.1 Limited Awareness
 - 6.4.2 Biases
 - 6.4.3 Tunnel Vision
 - 6.4.4 Disable via RULES

III-1.3 OPERATOR MODELS, PILOT DECISION LOGIC

1.3.4.2 FLIGHT POSTURE

- 1. Flight Posture Alternative Generation (aslct4)
 - 1.1 Mission postures (alt41)
 - 1.1.1 Standard mission
 - 1.1.2 Escort mission
 - 1.1.3 GCI following
 - 1.2 Other postures
- 2. Flight Posture Alternative Projection (aproj4)
 - 2.1 Compute expected value killed, lost (tloss)
 - 2.2 Compute ability to complete mission
- 3. Flight Posture Alternative Evaluation (aeval4)
 - 3.1 Basic score plus mission specifics
 - 3.1.1 Mission, escort, GCI factors
 - 3.1.2 Attack, evade/reengage, disengage
 - 3.1.3 BVR attack
 - 3.2 Apply hysteresis

DRAFT

III-1.3.4.4 DECISION LOGIC, PILOT POSTURE

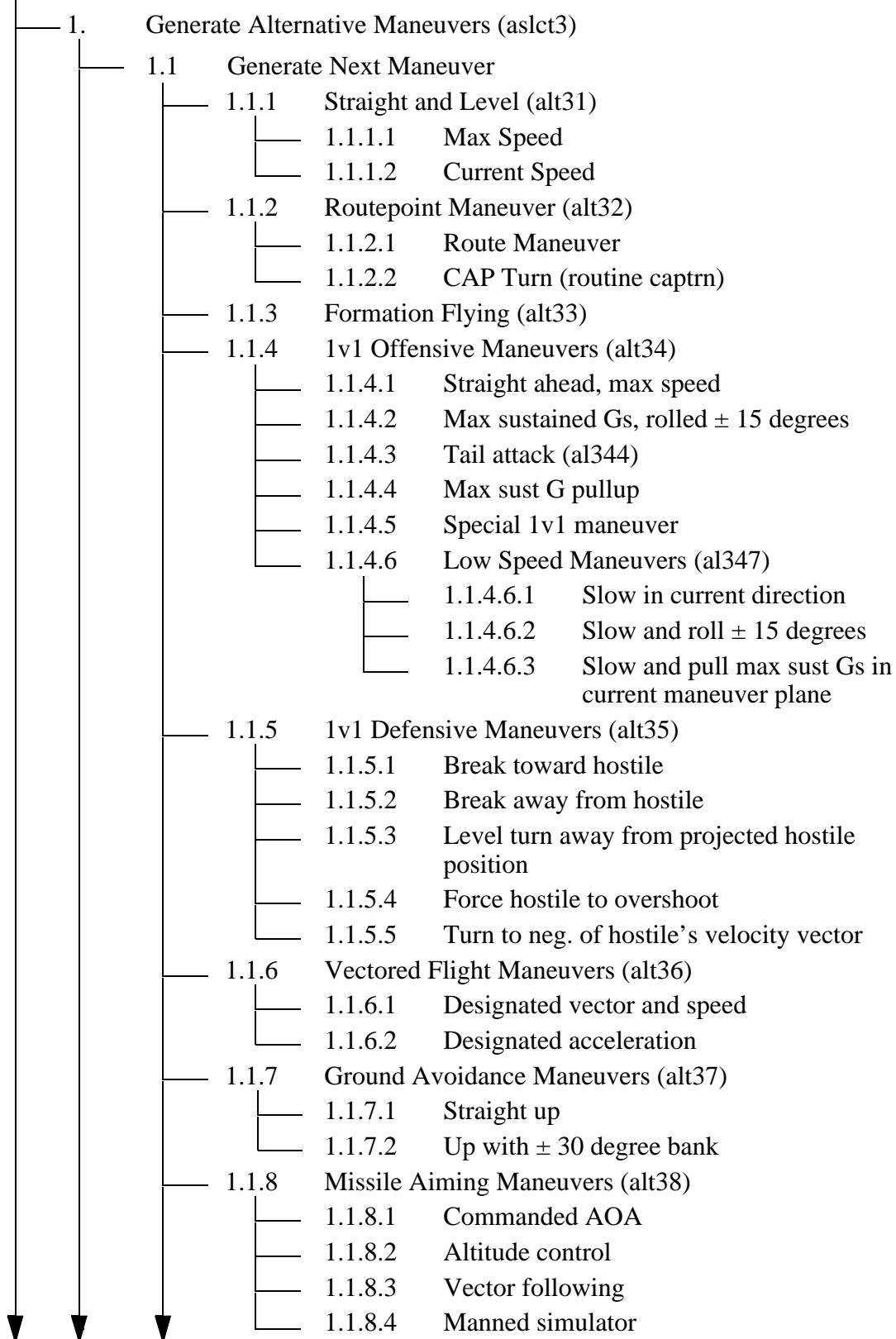
RADAR MODE/PATTERN SELECTION LOGIC (GIMBALED RADARS)

- 1 Radar Selection (selrdr)
 1. Select mode
 - 1.1 Production rule override (rrrule)
 - 1.2 Default logic
 - 1.2.1 Score STT for each target (rrsttv)
 - 1.2.2 Score scan/TWS modes (vscan)
 - 1.2.3 Select mode, process selection
 2. Select pattern position (rdrelv)
 - 2.1 Scan mode
 - 2.2 STT mode
 - 2.3 TWS mode
 3. Reset PRF control mode

DRAFT

III-1.3 OPERATOR MODELS, PILOT DECISION LOGIC

1.3.4.5 MAKE A MANEUVER DECISION



DRAFT

- 1.1.9 Missile Evasion Maneuvers (alt39)
- 1.1.10 Low Speed Recovery Maneuvers (alt3a)
 - 1.1.10.1 Straight down
 - 1.1.10.2 Roll ± 45 degrees from current
- 1.1.11 Illumination Maneuver (alt3b)
- 1.1.12 Disengagement Maneuver (alt3c)
- 1.1.13 Heading Perturbations (alt3d)
- 1.1.14 Escort-Bomber Maneuver (alt3e)
- 1.1.15 Barrel Roll Maneuver (alt3g)
- 1.1.16 A-pole/F-pole Maneuvers (alt3_17)
- 1.2 Impose RULES limits on Gs, Speed, Roll (prmnlm)
- 1.3 Limit throttle to reduce IR vulnerability (see routine thrlim)
- 2. Project Maneuver (aproj3)
 - 2.1 Format Specific Projection
 - 2.1.1 Desired rates format
 - 2.1.2 Desired altitude and heading format
 - 2.1.3 Desired acceleration format
 - 2.1.4 Desired velocity vector format
 - 2.1.5 Tracking maneuver format
 - 2.2 Reject Duplicate Maneuvers
 - 2.3 Compute Final Projected State Variables
- 3. Score Maneuvers (aeval3)
 - 3.1 Formation flying (evform)
 - 3.2 Route following (evrte)
 - 3.3 Offensive and defensive values (eclin)
 - 3.4 Ground avoidance (evgrnd)
 - 3.5 Vector following (evvec)
 - 3.6 Missile aiming (evmaim)
 - 3.7 Illumination (evilum)
 - 3.8 Mutual support (evmusp)
 - 3.9 Missile evasion (evevd)
 - 3.10 Low speed recovery (evlosp)
 - 3.11 Disengagement (evdis)
 - 3.12 Separation (evsep)
 - 3.13 Escort-bomber (evesc)
 - 3.14 Bad aspect avoidance (evbddr)
- 4. Select Maneuver

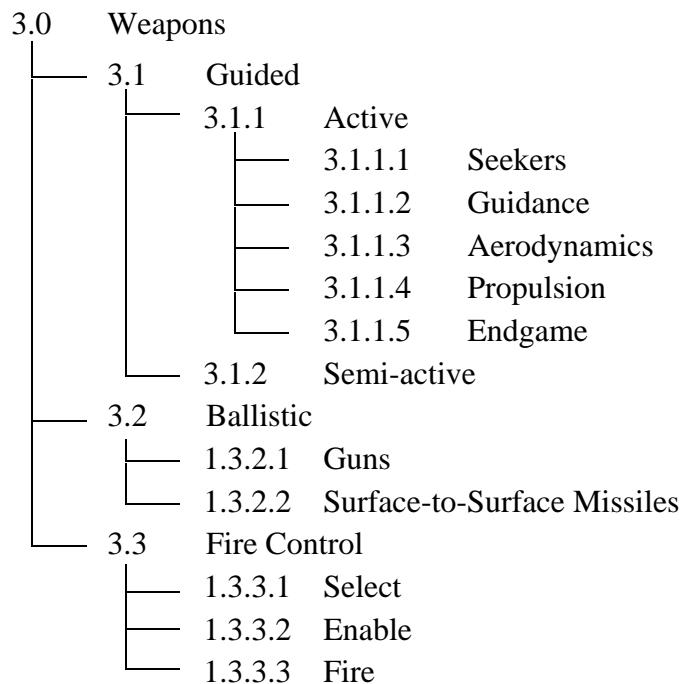
DRAFT

IV PHYSICAL SYSTEMS

1. Aircraft

- 1.1 Propulsion
 - 1.1.1 Compute Engine State (seteng)
 - 1.1.2 Compute Resultant, Effective Thrust (effthr)
 - 1.1.3 Fuel Flow (fflo)
- 1.2 Aerodynamics/Kinematics
 - 1.2.1 Control (rates)
 - 1.2.1.1 Compute Initial Aircraft Flight State (flacti, flact0, acarea)
 - 1.2.1.2 Roll & Pitch Lag Filter Frequencies
 - 1.2.1.3 Max Roll/Pitch Rates (ratmx1, ratmx2)
 - 1.2.1.4 Commanded Roll/Pitch Rates (gwreq)
 - 1.2.1.5 Resultant, Filtered Roll/Pitch Rates (pnnow)
 - 1.2.1.6 Resultant Yaw Rate
 - 1.2.1.7 Determination of Lift/AOA Needed for Pitch Response (aoanow)
 - 1.2.1.7.1 Lift Limit Mods to Pitch Rate (gldmx)
 - 1.2.2 Compute Final Aircraft Flight State (flact1)
 - 1.2.2.1 Angular Rates
 - 1.2.2.2 Orientation
 - 1.2.2.5 Position, Velocity, Acceleration
- 1.3 Signatures
 - 1.3.1 Static
 - 1.3.1.1 RF Cross Section
 - 1.3.2 Dynamic
 - 1.3.2.1 RF Cross Section
 - 1.3.2.2 Infrared
 - 1.3.2.2.1 Computation of Signal
 - 1.3.2.2.1.1 Plume Radiation
 - 1.3.2.2.1.2 Black Body (airframe) Radiation
 - 1.3.2.2.1.3 Hot Part Radiation
 - 1.3.2.2.1.4 Reflected Solar Radiation
 - 1.3.2.2.1.5 Reflected Sky Radiation
 - 1.3.2.2.1.6 Reflected Earth Radiation
 - 1.3.2.2.2 Compute Background
 - 1.3.2.2.3 Compute Foreground
 - 1.3.2.3 Visual
 - 1.3.2.3.1 Threshold Contrast
 - 1.3.2.3.2 Probability of Detection Calculation

DRAFT



DRAFT

IV PHYSICAL SYSTEMS

3	Sensors		
3.1	Radar	3.5	IFF/NCID
3.1.1	Gimbal	3.5.1	Pilot Selection
3.1.2	ESA	3.5.2	Interrogation
3.1.3	Detection	3.5.3	Response
3.1.4	Tracking	3.5.4	Response
3.1.5	Operator	3.6	RWR
3.1.6	Scope	3.6.1	Detection ML, SL, Rules
3.2	IRST	3.6.2	Tracking
3.2.1	Frame Scheduling	3.6.3	Operator
3.2.2	Sweep Scheduling	3.6.4	Display
3.2.3	Detection	3.6.5	Alarm
3.2.4	Tracking	3.6.6	Cue MAW
3.2.5	Operator	3.7	Visual Model
3.2.6	Display	3.7.1	Sector Search
3.3	MW	3.7.2	Detection
3.3.1	Detection	3.7.3	Post-Det
3.3.2	Tracking	3.7.4	Tests & Errors
3.3.3	Cueing	3.8	Voice Com
3.3.4	Display, Alarm	3.8.1	Scheduling
3.4	MAW	3.8.2	Obs. Msg.
3.4.1	Cued Detections	3.8.3	Orders
3.4.2	Tracking	3.8.4	Queries
3.4.3	Display	3.9	SFD-SAN
3.4.4	Alarm	3.9.1	SFD Trackbank
		3.9.2	Central SAN
		3.9.3	SAN Data Links
		3.9.4	Integrated Trackbank & Display

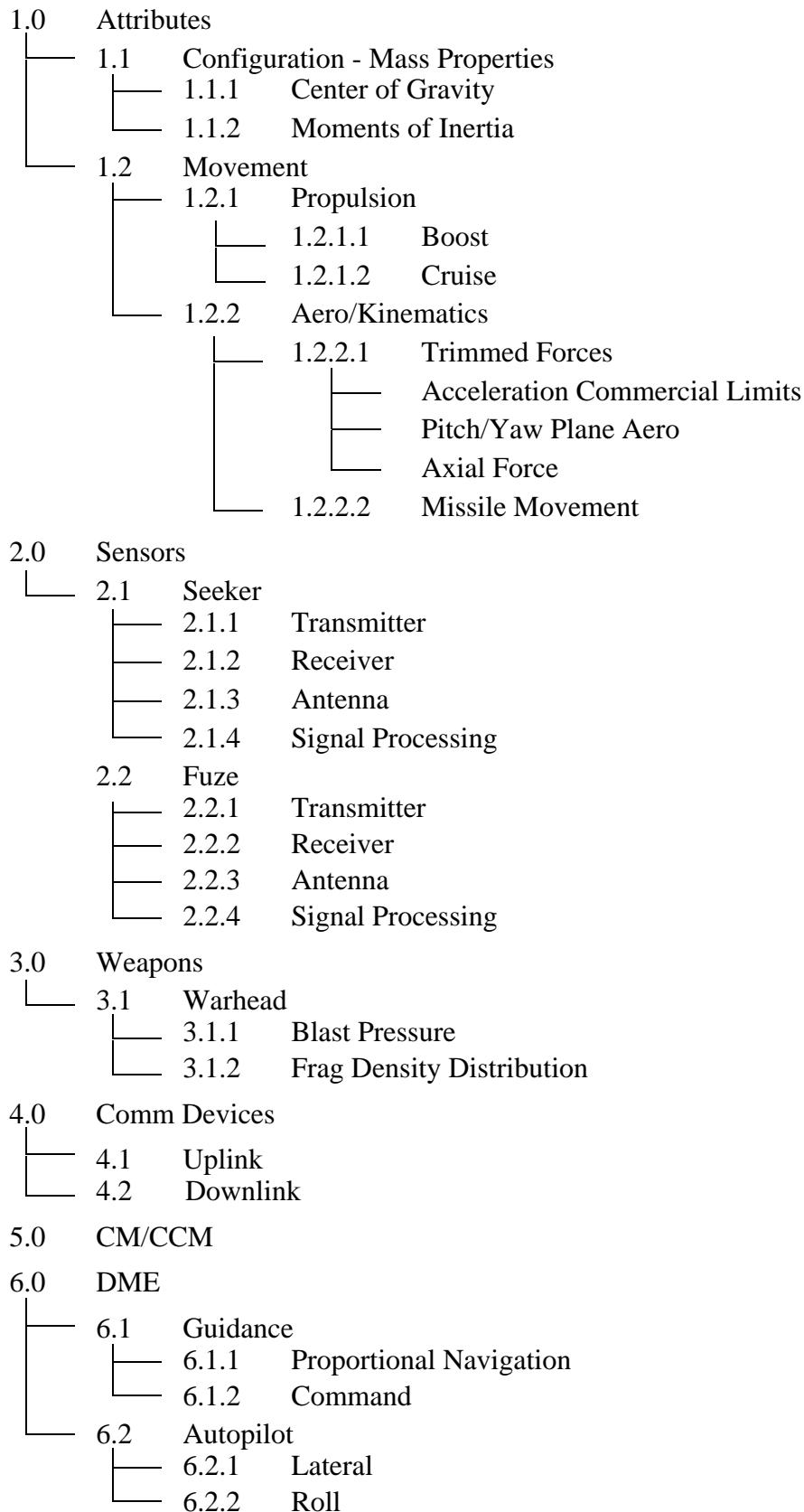
DRAFT

IV PHYSICAL SYSTEMS

- 4. Countermeasures
 - 4.1 CM
 - 4.1.1 Jammers
 - 4.1.1.1 Self Screening
 - 4.1.1.2 Stand Off Jammers
 - 4.1.2 Expendables
 - 4.1.2.1 Flares
 - 4.1.2.2 Chaff
 - 4.1.2.3 Towed Decoys
 - 4.1.3 Techniques/Effects
 - 4.1.3.1 General
 - 4.1.3.1.1 Ballistic
 - 4.1.3.1.2 Pk Degrade
 - 4.1.3.1.3 Centroid
 - 4.1.3.2 RF
 - 4.1.3.2.1 Noise (vs avionics)
 - 4.1.3.2.2 Noise (vs missiles)
 - 4.1.3.2.3 Deception (vs avionics)
 - 4.1.3.2.3.1 Anti-Detection
 - 4.1.3.2.3.2 Anti-Lock
 - 4.1.3.2.3.3 Cross Polarization
 - 4.1.3.2.4 Deception (vs missiles)
 - 4.1.3.2.4.1 Anti-Missile
 - 4.1.3.2.4.2 Cross Polarization
 - 4.1.3.2.4.3 Pk Degrade
 - 4.1.3.3 Communications
 - 4.1.3.4 SAN Data Link Interruption
 - 4.2 CCM
 - 4.2.1 Weapons
 - 4.2.1.1 IR

DRAFT

PLATFORM AIR-TO-AIR MISSILE



DRAFT